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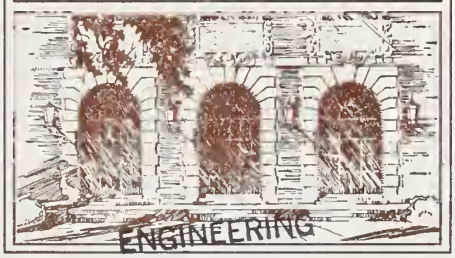

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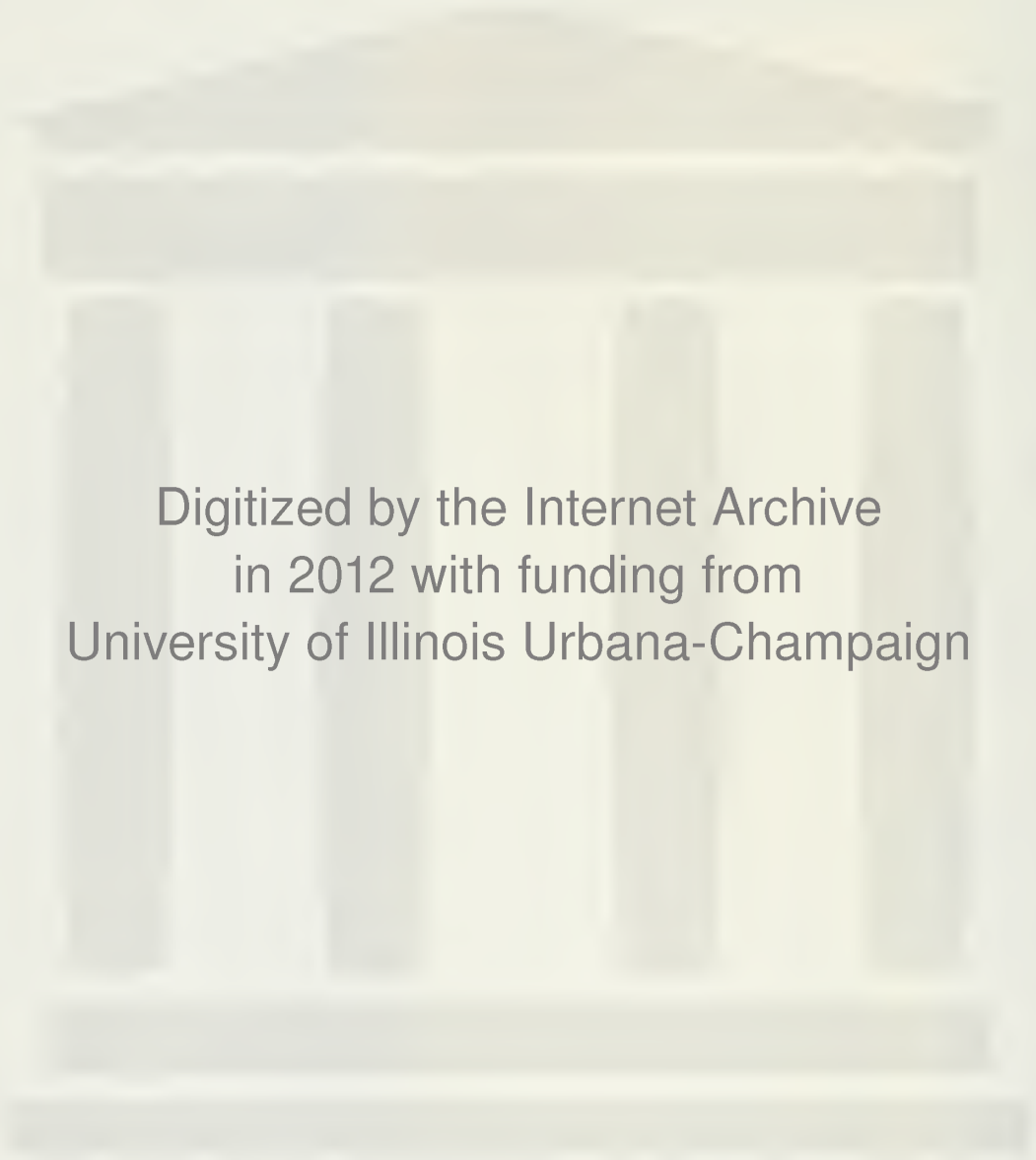
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A RAILWAY TRUST FUND

By

Bruce Hannon

April, 1974

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A RAILWAY TRUST FUND

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Abstract

The operation of vehicular freight carriers (barge, train, truck) are examined for flexibility, costs, subsidies, regulation and resource demands. The conclusion reached is that trains compete with both barge and truck but the latter two do not compete with each other. Truck-train competition is reaching equilibrium while barge-train competition continues. Trains are substantially outsubsidized relative to the other two modes. Rail companies have an unattractive financial status. Yet rail energy demands are the smallest for any mode on a freight ton-mile basis. Employment requirements of the three modes vary generally with the freight costs. Trucks are most sensitive to the dollar cost of fuel; water transport is slightly less sensitive than train transport.

The conclusion is that rail freight hauling should be protected from unequal government subsidies to other modes. Government withdrawal from the subsidy of freight transport is urged. In lieu of withdrawal, federal ownership and maintenance of the nation's railways with appropriate user fees, is recommended.

Introduction

The purpose of this paper is to delineate the major resource-demanding, inland, intercity transport modes; to demonstrate their relative competitive positions; and, to suggest a method for balancing historical biases in order to promote a more efficient overall transport system.

Transportation rights-of-way are designed, with the possible exception of the airways, exclusively for freight vehicles. Barge waterways and locks, railroad tracks and concrete highways are constructed specifically for depth of canal and lock, strength of rail, and thickness and width of pavement, for their respective freight carriers. Because of their speed and loading, right-of-way maintenance costs largely accrue to the freight carriers (Oehman and Bielak, 1970, Table 25). Passenger vehicles, scarce today on water and rail, are nearly incidental to the design and maintenance of the right-of-ways (Oehman and Bielak, 1970, Table 25). Since a majority of U.S. transportation rights-of-way are designed for freight, and a major share of the transport cost is in the construction, operation, and maintenance of the right-of-way, and since government transport subsidies have historically shared in right-of-way cost, I shall limit this study to a right-of-way analysis of the competing trio of intercity freight transport: inland barge, railroad, and truck.

Competitive Structure of Barge, Train, and Truck

Barge freight, in the sense of this study, means all Interstate Commerce Commission regulated inland freight that moves on water, including the freight on the Mississippi and Ohio Rivers, the Great Lakes, and the intercoastal

canals. A barge is a rectangularly shaped vessel, about one hundred feet long, filled with a bulk commodity such as gasoline. Often, several barges are assembled into an oblong-shaped, closely packed collection called a tow, which is pushed by a diesel powered boat up and down the major rivers, canals, and lakes of the country. The barge traffic moves through locks and canals constructed, operated, and maintained, without user charge, by the U. S. Army Corps of Engineers. The barge industry is only lightly regulated, and little fuel use data are available. Results of barge energy studies are inevitably controversial.

In this study, rail freight includes all classes of rail freight except where noted. Rail freight includes unit trains, generally composed of a series of about one hundred identical railroad cars carrying identical freight. These special trains compete directly with the larger barge tows over the large hauling distances. Unit trains and the large barge tows often return empty to their point of shipment.

Trucks in this study, generally refer to intercity combination (tractor-trailer) trucks, although there are an increasing number of the larger capacity double trailer trucks. Trailers can be shipped by train (piggyback), deposited for loading or unloading and then be picked up by another tractor. Long-distance, large trucks traveling interstate highway compete with trains, particularly for perishable freight. Large intercity trucks, particularly those which are privately owned, return empty to their point of shipment.

Of all U.S. oriented inland freight, 16.2 percent was carried by barge, 38.5 percent by train, and 22.2 percent by truck in 1971 (ton mile basis,

1.9 trillion, total), approximately the same distribution as in 1972 (Association of American Railroads, 1973a, p. 36). The remaining materials moved by pipeline. The specialized nature of pipelined materials, and their generally low flexibility, removes them from consideration in this study.

Flexibility, as represented by average speed and range, is generally regarded as a measure of competition. Another measure of competition is the average revenue per ton mile, provided it is an accurate assessment of all expenses. Still another measure is the total right-of-way network length and circuity. These measures are shown in Table 1 for barge, rail, and truck freight. The cost range between modes is sizeable, but barge costs do not include any right-of-way costs, and truck costs include approximately half to three-fourths of their allocated amount of right-of-way costs (Oehman and Bielak, 1970). Rail costs reflect private ownership of the right-of-way, including right-of-way taxes. It is not known how much these costs are influenced by the large land subsidies given, more than a century ago, to the railroads, particularly in the West. Since the costs do reflect the scale of the average speeds and geographic intensity of the right-of-way network, it is somewhat surprising to find that the railroads haul farther on the average than the slower barges. The more flexible trucks haul about half as far as rail on the average, at twice the average speed. Trucks, characteristically moving "overnight" distances, are well suited to the recent dispersion of industry along the interstate system. Offsetting, to some extent, the large difference in cost of hauling between the three modes is the fact that inventory and warehousing costs are generally smaller for the faster modes. Small inventories, however, have the disadvantage of being especially sensitive to resource shortages, for example, a fuel shortage which would affect freight deliveries.

The numbers in Table 1 are, of course, averages and do not reflect the detail of modal competition which prevails in specific areas. Table 1 is intended to allow a relative ranking of the modes. In general, it appears that both barge and truck compete with rail, but not with each other. Barges are competing with rail on the long haul commodities such as minerals and grain, while trucks have already taken most of the shorter haul rail deliveries. From 1960 to 1970, the intercity haul distance by barges increased 16 percent, by rail it increased 11 percent, and by truck it decreased 4 percent (U. S. Department of Transportation, 1972, pp. 25, 30, 35), indicating again that barges and trains are competing for unit long-haul operations, and that train and truck competition has probably reached equilibrium. This arrangement is further indicated by the increasing number of trucks traveling by rail (Association of American Railroads, 1973a, p. 36). Such an arrangement is probably not the most energy-efficient rail hauling process since these "piggyback" trains run especially fast, have higher than normal wind resistance, and have lower than normal cargo-to-gross weight ratio. Trains sometimes act as feeder lines for barges, and trucks occasionally perform this role for both of the other modes. Truck-barge or truck-rail combinations sometimes act to compete with the remaining mode.

Expenditures for Right-of-Ways

Total Federal costs for the 25,000 miles of inland waterways (excluding the Great Lakes) was $218.0 million in 1971; this included all construction, operation, and maintenance costs (Association of American Railroads, 1973b, Tables 5 and 7; and see also, Kearney: Management Consultants, 1974, p. 17).

Inclusion of these costs in the barge costs (see Table 1) would increase average rates by about one-third (Association of American Railroads, 1973a, 1973b; U. S. Department of Transportation, 1972). A recent Federal interagency task group indicated full federal costs could be recovered with a twenty-four cents per gallon fuel tax, which would result in a 60 percent diversion of barge freight to other modes (Swift and Spencer, 1973). Total Federal costs for highway construction was $5.6 billion in 1971 (state and local government costs were an additional $16.8 billion in 1971) to support about 920,000 miles of federal-aid highways (Association of American Railroads, 1973b; Bureau of the Census, 1971, Table 838). In 1969, all combination trucks were paying about 76 percent of their incurred costs, while the largest trucks, semi- and full trailers, were paying 56 percent of their allocated cost from interstate highway use (Oehman and Bielak, 1970), compared with a 98.2 percent user share on all Federal aid primary highways (Oehman and Bielak, 1970). Inclusion of these unpaid right-of-way costs would increase intercity truck rates about 5 percent on the average (Oehman and Bielak, 1970; see also, U. S. Department of Transportation, 1972; Association of American Railroads, 1973b). Railroads spent slightly over $2 billion in 1971 to maintain, construct, and pay taxes on their 335,000 miles of track (Association of American Railroads, 1973b, Table 10; Association of American Railroads, 1973a, p. 48).

Government current dollar expenditures on inland waterway development increased by 23 percent between 1960 and 1970 (Association of American Railroads, 1973b). Government current dollar highway construction and maintenance expenditures increased 94 percent during that time, explaining in part

the shorter truck haul distance noted above (Association of American Railroads, 1973b). However, lock and dam construction now appears to be the limiting factor in increasing barge traffic (Kearney: Management Consultants, 1974, pp. 11-12). Furthermore, the originally planned goal for a 42,000 mile interstate highway system has now been reached, and plans have been laid for its extension. The interstate highway system is probably not yet in its peak maintenance period, although annual maintenance costs now run about twice the annual construction expenditures (Association of American Railroads, 1973b). Due to the increased fuel economies of lower highway speed and small personal vehicles, it is likely that Highway Trust Fund contributions (derived from fuel taxes) will decrease. However, rising maintenance costs will accrue as the system matures under continued use. Thus, there is a high probability that the Federal Highway Trust Fund will have to be converted from a construction to a highway maintenance fund, and the fuel tax on cars and trucks may have to be increased.

Figure 1 shows the growth of highway construction (and reconstruction), and of highway motor freight between 1929 and 1972. The mileage represents the "traveled way," and does not distinguish between multilane highways. After World War II, the expansion in highway construction was followed by a rapid expansion in freight hauling. Due to the decline in the highway building rate one might expect an eventual leveling off of truck freight movement. However, the years 1956 to 1972 represent a large portion of multilane, interstate Highway Trust Fund construction that was particularly useful to the trucking industry. Most of the highway construction in Figure 1 was for new highways as opposed to reconstruction. For example, the total length of federal-aid highways increased by 290 percent from 1940 to 1969 (Bureau of the Census, 1971, Table 838), during which time the total length of

railroads actually shrank.

Figures 2 and 3 give a more detailed view of the adequacy of railroad maintenance expenditures. Figure 2 shows the precipitous decline in new rail laid per year since 1945. It is apparent that railroad owners decided to abandon the business in the early 1950's, in spite of the steady-to-rising freight business. Figure 3 shows the declining constant dollar of right-of-way maintenance per ton mile of freight hauled. At the same time, the average speed of freight trains was increasing until about 1962 or 1963, when, apparently, inadequate track maintenance overcame the efficiencies of unit trains and diesel-electric locomotives.

Railroads have increased current dollar expenditures on right-of-way by 47 percent between 1960 and 1970, although total track miles decreased almost 14 percent since 1939 (Association of American Railroads, 1973b, Table 10; Association of American Railroads, 1973a, p. 48). They have made two major maintenance reducing innovations in the last ten years: roller wheel bearings and continuous welded rail.

The most revealing railroad maintenance statistic, however, is the rising number of maintenance related train accidents shown in Figure 3. The accident rate more than quadrupled between 1960 and 1970, during which period the ton miles hauled increased by 33 percent, and passenger miles declined. An examination of the liabilities record from 1965 to 1971 (Moody's Investor Service, 1973, p. a49) for all U.S. railroads shows that while shareholders' equity in capital stock declined about 5 percent, the insurance and casualty reserve increased by 235 percent (current dollars), indicating that the railroad companies have chosen the terminal solution of substituting insurance premiums for right-of-way maintenance.

Government Regulation

About 14.5 percent of all barge freight (U.S. Department of the Army, Corps of Engineers, 1971), about 36 percent of all truck freight (Moody's Investor Service, 1973, p. a64), and 100 percent of all rail freight is controlled by the federal government's Interstate Commerce Commission (ICC). For example, most dry and all liquid commodities carried on barges are exempt from ICC regulation (Kearney: Management Consultants, 1974, pp. 11-12). Barges also receive a subsidy in the form of federally guaranteed loans and mortgages on their equipment through the Maritime Administration (Moody's Investor Service, 1973, p. a109; U. S. Public Law 92-507). The power of ICC regulations over trucking is less severe than for railroads (Moody's Investor Service, 1973, p. a64). Within the trucking industry the growth of private, unregulated carriers is much greater than that of the regulated common carrier (Moody's Investor Service, 1973, p. a64) indicating that the regulated price is too high.

One suspects that when part of an industry is unregulated, that part tends to experience relative growth, since the purpose of regulation is generally to level out competitive advantage. One of the problems of partial regulation is, of course, that it succeeds in hampering the regulated, but then fails to stop or modify its procedures because the collective power of the unregulated prevents a change in the regulation procedure. A further problem of partial regulation is that the private unregulated carriers tend to one-way hauling, i.e., they haul their product to its destination and return empty. This is particularly true in trucking and barging, and to some extent true in railroads because of the diversity of privately owned rights-of-way. Such a process is not as fuel efficient as contract carriers

who often haul freight in both directions. Another problem of partial regulation or of diverse private right-of-way ownership is that of the "Gateway." In order to reduce competition or avoid travel over a competitor's right-of-way, vehicles are routed away from the most direct course to a specified destination. Such practices are more resource consuming (energy consuming, in particular) and are controllable through a uniform regulatory scheme, and uniform ownership of the right-of-way.

In setting the rate for a given product with a specified origin and destination, the Interstate Commerce Commission is inclined to use carrier costs to determine the cheapest possible rate, even though they have been instructed otherwise (Interstate Commerce Commission, 1973). Such a procedure obviously omits the right-of-way costs borne by the public. As noted above, this is a considerable omission in the waterways case. The ICC also uses distributed or average carrier costs, rather than marginal costs, in setting rates. This latter procedure would not always produce the lowest possible rate.

Financial Status

In 1972, seventeen railroad companies (out of a total of ninety-four) failed to meet the fixed charges of their operation (Association of American Railroads, 1973a, p. 4). The sixth rail company in as many years filed for bankruptcy (Association of American Railroads, 1973a, p. 4). Since 1967, over 24,000 miles of track have been placed in receivership (Moody's Investor Service, 1973, p. a79).

Net income as a portion of revenue was found to be 6.6 percent for barges, 3.9 percent for rail, and 2.1 percent for trucks in 1973. However, return on equity is 10.6 percent for barges, 2.7 percent for rail, and 12.9 percent for

trucks, clearly indicating the strained economic state of railroads (Kearney: Management Consultants, 1974, pp. 11-12).

Resource Demands

In this section, the total energy and labor requirements in moving one average ton mile of freight by the three modes -- barge, train, and truck -- are calculated. Before proceeding, however, a brief explanation of our Energy Employment Policy Model is necessary.

To calculate the energy cost of one unit of an item, we ask: What are the direct inputs of goods and services required to produce that item? For each of these inputs, we ask: What are their inputs? And so we continue until we reach such a multitude of small inputs that leaving off the next round does not significantly change the total requirements. For example, the direct inputs required to produce this report were quantities of paper, ink, labor, and printing machinery. The secondary round of inputs to the paper, for example, included wood pulp, cotton, clay, labor, and paper-making machinery. The tertiary round of inputs to the wood pulp included wood, chemicals, labor, and machinery. The process continues as a tree of inputs, infinitely branching. In some cases, branches interlock, as in the case of the consumption of paper (packaging, for example) in making ink. With each branch of this complex tree of inputs, one can associate the energy required to produce the desired unit. Adding all these energies together yields the total energy required per unit of final output.

A more manageable way to accomplish the same result is based on input-output theory, for which Wassily Leontief recently received the Nobel Prize in economics. The kernel of the method is to first divide an economic system into recognizable sectors such as steel production, feed grain production,

railroad services, etc. Then for a given period, usually a year, assume that the total dollar output of a given sector is the sum of a certain fraction of the total dollar output of each sector of the economic system plus that output delivered for final consumption. The needed fractions are found from actual dollar-transaction data between each sector and all the others. The result is a set of equations in which the total sector outputs are the unknowns. The object of the method is to simultaneously solve these equations for the total sector outputs. The process requires large, modern computers if the economy is divided into many sectors.

The result is a second set of equations, this one expressing the total dollar output of each sector as the sum of a certain fraction of each sector's deliveries to final consumption. The sum of the fractions required for one unit of a given sector's deliveries to final consumption is called the dollar intensity or output multiplier for that sector. For example, we might find that a dollar's worth of output of automobiles for consumption requires a total of three dollars worth of outputs from the other sectors. Then we say that the dollar intensity (or multiplier) for automobiles is three. This intensity would include, for example, the value of all the steel production resulting from the dollar's worth of consumer demand for autos, which would in turn include the value of the steel consumed directly by the auto manufacturing plants, and the value of steel consumed indirectly--in replacing depreciated trucks which deliver autos to salesrooms, perhaps.

With knowledge of the way in which energy is directly consumed by each sector, dollar flows can be transformed into energy flows, in British thermal units (Btu.), of a given type of energy (coal, oil, electricity, natural gas, etc.). Thus, one can derive the energy multiplier for a unit of delivery to final consumption by a given sector. Dollar outputs can similarly be

converted to employment figures (by occupation), amounts of pollution (by type), land use, etc.

The U.S. Department of Commerce has collected sufficient dollar data on 363 sectors of the economy for the years 1963 and 1967 to enable the calculations described above to be made. We have transformed the 1963 sector dollar flows to energy flows between sectors and developed the total employment requirements for each sector in 1963 (Herendeen, 1973; see also Hannon, 1974; Bezdek et al., 1973).

To apply the model to a specific transportation mode one must first determine the fractional breakdown of the dollar cost of a ton mile of freight. These categories might be purchases of fuel, machinery, buildings, equipment and right-of-way maintenance, insurance, financing, right-of-way construction, etc. These values must be deflated to the year 1963 and identified with the appropriate sector in the model. The dollar values in each sector are then simply multiplied by the energy multiplier from the model (direct fuel energy is tabulated directly from user data) and summed to the total direct and indirect energy per ton mile of freight by that particular mode. The results are given in Table 2. The truck freight system is obviously more expensive than the rail freight system, per ton mile. These cost differentials reflect the truck system's greater flexibility and speed. They also demonstrate the effects of air drag and the stronger railroad labor union. Circuity, the actual traveled distance divided by the straight line distance between origin and destination, is nearly the same for rail and truck (Bezdek and Hannon, 1973) but barge circuity is 38 percent greater than rail (Sebald, 1974) as seen in Table 1.

It is apparent that initially a move from truck to rail shipping would save energy, reduce dollar cost, and reduce employment. Some of the dollar cost reduction would probably be required to build, operate, and maintain expanded railroad terminal facilities. Nevertheless, the following calculations are instructive. Assuming that average and marginal costs per ton mile are equal, and that the cost difference shown in table 2 persist throughout the change period, about $28 billion dollars would have been freed in 1971 had all intercity truck freight moved by rail. Under the same assumption about costs, the switch to rail would have saved about 190 million barrels of oil (energy equivalent) in 1971, and disemployed about 450,000 workers. If the $28 billion was absorbed as a federal tax and spent on railway construction (Bezdek and Hannon, 1973), the net savings from the shift of truck freight to rail would be 100 million barrels of oil (energy equivalent) per year, and a net increase of 1.6 million jobs.

From Table 2 we find that if all barge traffic had moved by rail, freight cost would have increased about $4 billion per year. Assuming this cost increase was passed through to the consumer, (Sebald and Herendeen, 1973) and reduced his general expenditures proportionately, energy use would have decreased about 48 million barrels of oil (energy equivalent) per year, and 130,000 jobs would have been lost, in 1971.

In applying the model to the construction of highways and rail roadbeds, it was found that the latter process is much less energy demanding and slightly more labor demanding than the former (Bezdek and Hannon, 1973). It was also shown, using current load factors (Sebald and Herendeen, 1973), that rail passenger transport is more energy efficient than intercity travel by auto, although bus travel was the most energy efficient of all passenger modes

(Bezdek and Hannon, 1973).

Table 3 shows the freight modes' sensitivity to the dollar value of energy in 1963. From Table 3 we see that the three transport modes spend most of their energy dollar on refined petroleum. The second most important energy source in terms of dollar cost is electricity, followed by natural gas and coal. Railroads paid slightly more for all energy forms than did water transport, and trucks paid substantially more than railroads. As an example of using the information in Table 3, suppose that the price of refined petroleum doubled, and all price increases were fully passed on to the consumer. Then the consumer of water transport services would see a 3.6 percent increase, the consumer of railroad services would see a 3.8 percent increase, and the consumer of motor freight services would see an increase of 4.8 percent, in dollar costs. Thus, trucks were 25 percent more sensitive to the producer's price of refined petroleum than were railroads and railroads were 7 percent more sensitive than water transport. Note that here, water transport includes ocean going vessels. The dollar cost of energy for inland water transport is probably higher than shown in Table 3 due to the lack of streamlining of barges, and the relatively small loads per barge tow. I conclude, therefore, that inland barges and railroads are about the same in sensitivity to energy prices.

Conclusions

Barges and trains are still competing. Competition between trucks and trains has reached equilibrium. Barges are currently restricted by lock facilities and channel depth. Trucks are meeting difficulties with fuel costs, and ultimately will be responsible for major highway maintenance costs. Railroads, out subsidized and relatively over regulated, are on the verge of

financial disaster. They began to abandon maintenance of right-of-way in the mid-fifties, and have been substituting the lower cost but short run alternative of insurance reserves to cover accident costs. Railroads have been proceeding into bankruptcy at an increasing rate since 1960. Barge and truck business is relatively healthy. Yet railroads represent the single best combination of flexibility and low resource demands of the three freight modes.

Suggestion: The Railway Trust Fund

It is probably true that some government regulation begets more. To preserve the railroads, the federal and state governments should abandon all subsidies on barges and trucks, and let the railroads compete on an equal footing. This means the cessation of directly guaranteed loans and mortgages to the barge companies, and the charging of the full, allocable right-of-way construction, operation, and maintenance costs to the barge and truck companies. Such a process would obviously meet with substantial resistance from barge and truck companies and their supporting industries. Increased regulation of barges and trucks, private or contract, is necessary to protect the contract carrier from privately based, but less energy-efficient, competition. This, too, would no doubt be unpopular.

The only alternative to subsidy removal and deregulation is an equitable subsidy and regulation program for all transport modes. An evenhanded regulation scheme could be adopted beginning with a substantial revision in Interstate Commerce Commission rate setting procedures. The ICC should stop setting rates on the basis of costs directly incurred by the transport mode (Interstate Commerce Commission, 1973). Such a procedure obviously excludes the cost, to the public, of barge and truck subsidies, and unjustly slants freight rates in favor of the barge and truck modes. Marginal cost (including

right-of-way user costs) rate-setting procedures should also be adopted. Much more complete reporting procedures are needed for waterway users.

The second, and major, equilization is for the federal government to acquire all rail roadbeds, and to suitably reconstruct and maintain them. This would include acquisition of all structures related solely to the rail roadbed, but would exclude structures relating to the maintenance and operation of the rolling stock. These latter buildings and the transport equipment would remain in private hands.

Such a scheme is possible under Section 1.02 of the recently passed Rail Reorganization Act (Public Law 93-236). The act does not prevent the U.S. Railway Association (USRA, established to reorganize the Northeastern Railways) from transferring all U.S. roadbed and associated structures to Conorail (the pseudo-private government corporation which will operate the reorganized Northeastern U.S. rail companies). Under this plan all current railway maintenance employees become employees of Conorail, which should eventually become a totally private corporation. Thus, the problem of converting union labor to government employees is avoided.

To aid in the design and construction-maintenance supervision of the U.S. rail roadbed, I suggest that a substantial fraction of the 30,000 civilian employees of the U.S. Army Corps of Engineers be transferred to Conorail (Association of American Railroads, 1973b, Table 11). Approximately 12,000 of these Corps personnel are involved in the design, construction, operation, and maintenance of the nation's waterways (Office of Management and Budget, 1974). The remainder are basically involved in structural flood control, which is now negated by the passage of the national Flood Disaster Protection Act of 1973 (Public Law 93-234).

The cost of owning the nation's rail roadbeds is probably about $6 billion annually, about the size of the current Highway Trust Fund. However, it is likely the cheaper of the only two apparent alternatives: buy the tracks or eventually buy the entire U.S. rail operation.

The cost should include the railroads' annual carrying charge on roadbed investment, a suitable maintenance expense, and a property tax program (phased out slowly as new area business develops). In 1971 this annual cost was estimated by the railroads at $3.2 billion (Association of American Railroads, 1973b, Table 11). Doubling their maintenance costs to correspond to the 1950 level (see Figure 3, $1.6 billion per year), and assuming a complete rebuilding program over the next ten to fifteen years ($1.2 billion per year), the Railway Trust Fund would require an annual commitment of about $6 billion.

Repayment of these funds could be scheduled by the Interstate Commerce Commission which should raise the repayment from rail and barge company simultaneously until the 50 percent level is reached. Then the ICC should increase the repayment of all three modes simultaneously. Failing to extract the full users fees, the ICC should act to restrict nontransport oriented investment on the part of any of the right-of-way users.

Following this general outline of the government moving toward an overall transport policy of equal subsidy and regulation, and eventual government withdrawal from the process, should not only maintain a flexible, efficient national transport process, but should also provide a model for the style of government control in other actions.

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	Barge[a]	Rail[c]	Truck[c]
Speed[b], Miles/Hour	6[e]	20[f]	40
Haul Distance, Miles[h]	330	490	260
Miles of Right-of-Way	25,000[g]	335,000[g]	920,000[d]
Circuity[k]	1.70	1.25	1.20
Revenue, (Cents) Per Ton Mile[j]	0.29	1.35	7.21

(a) Inland Barges; includes intra- and inter-coastal and Great Lakes movement.

(b) Average route speed: includes waiting for locks, "slow orders," etc. Barge speed is upstream-downstream, loaded-unloaded average on Mississippi and Ohio Rivers. Truck speed: John Reith, Assistant Director, Department of Research and Transport Economics, American Trucking Association, Inc., Washington, D. C., 19 March 1974 (personal estimate, 40-42 mph).

(c) Class I railroads and Class I intercity trucks.

(d) Primary and secondary federal-aid only, U. S. Department of Commerce (1971).

(e) Missouri Pacific (1973).

(f) Association of American Railroads (1973a, p. 43,44).

(g) Kearney (1974, p. 17).

(h) U. S. Department of Transportation (1972, p. 25,30). Association of American Railroads (1973a, p. 35).

(j) U. S. Department of Transportation (1972, p. 38).

(k) Average deviation from great circle distance. Barge; Sebald (1974). Rail and truck; Church (1970).

Table 1. The Average Speed (1970), Range (1970), Miles of Right-of-Way (1971), and Revenue (1969) Per Ton Mile for Intercity Barge, Rail and Truck.

Mode	Cost or Revenue, Cents	Total Energy Use	Total Employment Demand
Truck[c]	8.0	4100	2.4
Rail Freight[b]	1.6	1600	1.4
Barge[d]	0.3	1600	0.6
Truck/Rail Ratio	5.0	2.6	1.7
Barge/Rail Ratio	0.2	1.0	0.4

(a) Costs are: Dollars and energy: Cents and Btu per ton mile; Employment, man-years per million ton miles. Employment does not include household or government industries. All costs are for services given between mode terminals only. Note that these data are the average for the entire mode.

(b) The railroad companies which compete directly with the barges are somewhat (1330 Btu/TM) more energy efficient than barges. The trailer train, hauling trucks ("piggyback"), competes directly with long-distance highway trucking, and is substantially less energy efficient than the average for rail shown above. See Sebald (1974), Sebald and Herendeen (1973).

(c) Dollar cost: American Trucking Associations, Inc. (1973). Energy and Labor costs: Penner (1974). Does not include full right-of-way costs.

(d) Barge dollar cost estimated from (U.S. Department of Transportation, 1972, p. 38); does not include right-of-way cost. Energy: direct (Sebald, 1974), indirect fraction assumed equal to that of railroads. Labor; (Association of American Railroads, 1973a, p. 36; Bezdek et al., 1973; U. S. Department of Commerce, 1969; Bullard, 1974). Circuity of rail and truck approximately equal (Bezdek and Hannon, 1973). Barge circuity is 38 percent greater than rail (Sebald, 1974) and the above barge costs were increased accordingly to compare with truck and rail.

Table 2. A Comparison of the Estimated Average Dollar, Energy and Employment Costs[a] of the Freight Transport Modes Using Intercity Highways or Railroads for 1971.

Fuel Type	Water Transport[b]	Railroads[c]	Motor Freight[d]
Coal	0.16	0.18	0.09
Crude Oil	1.84	1.94	2.40
Refined Petroleum	3.55	3.79	4.75
Electricity	0.73	0.70	0.82
Natural Gas	0.51	0.53	0.47
All Energy[e]	5.07	5.45	6.33

(a) Values do not include taxes.

(b) Includes ocean going vessels.

(c) Includes all classes of railroads, passenger and freight.

(d) Includes all trucks, urban and intercity.

(e) Double counting, i.e. counting the cost of electricity which includes say, the cost of coal input, and then adding on the cost of coal, is avoided.

Table 3. Total (Direct and Indirect) Dollar Values[a] Expended for Energy of Various Types per Dollar of Services Delivered to Final Consumption by Water Transport, Railroads and Motor Freight, in Cents per Dollar, 1963 (U. S. Department of Commerce, 1969; Bullard, 1974).

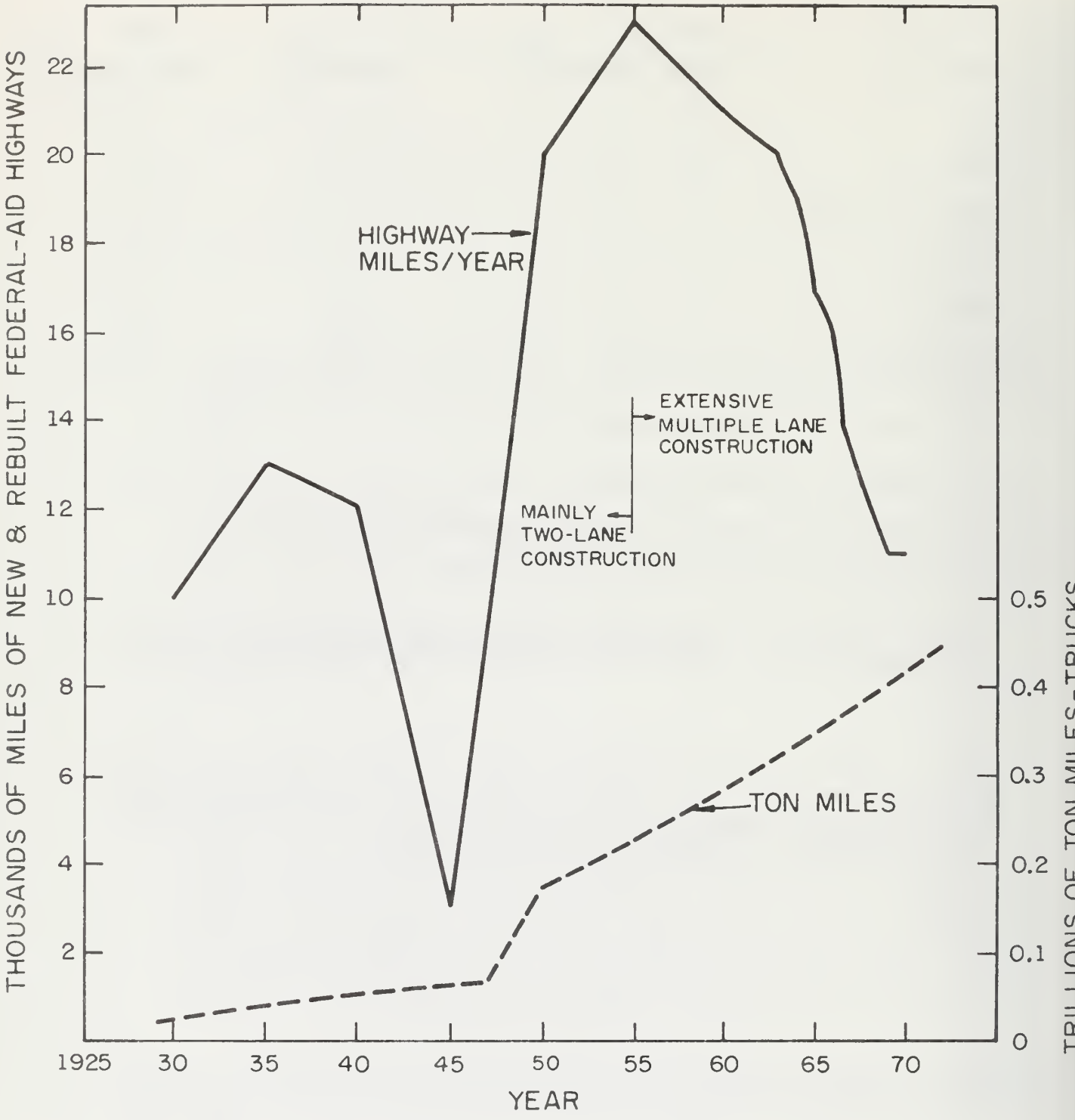

FIGURE 1. TRAVELED WAY MILES OF FEDERAL-AID HIGHWAY & INTERCITY TRUCK TON MILES, BY YEARS, 1929-1971 (U.S. DEPARTMENT OF COMMERCE, 1971).

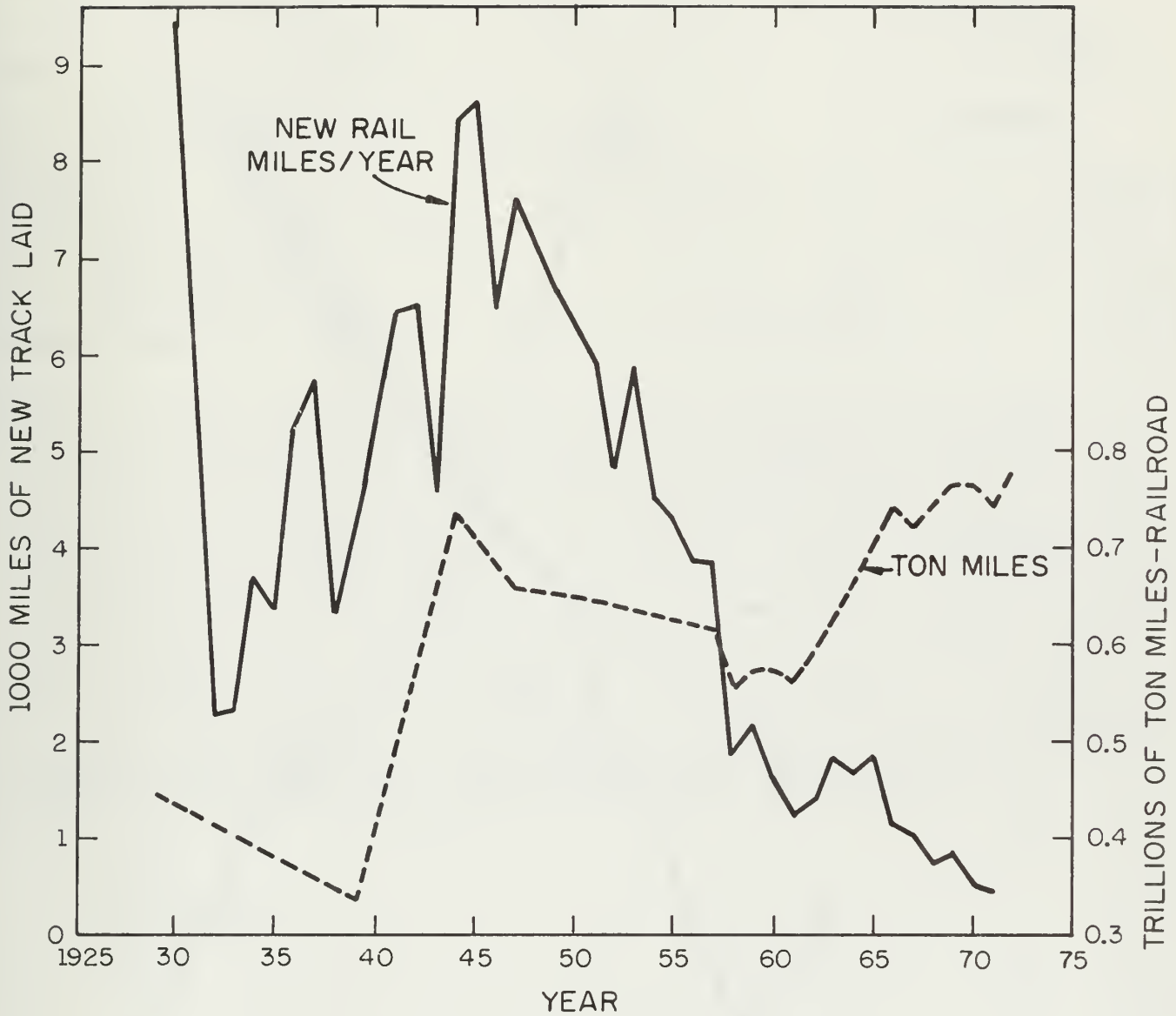

FIGURE 2. MILES OF NEW TRACK (RAILS) & RAILROAD TON MILES, BY YEARS, 1929-1971 (MOODY'S INVESTOR SERVICE, 1941 AND 1973).

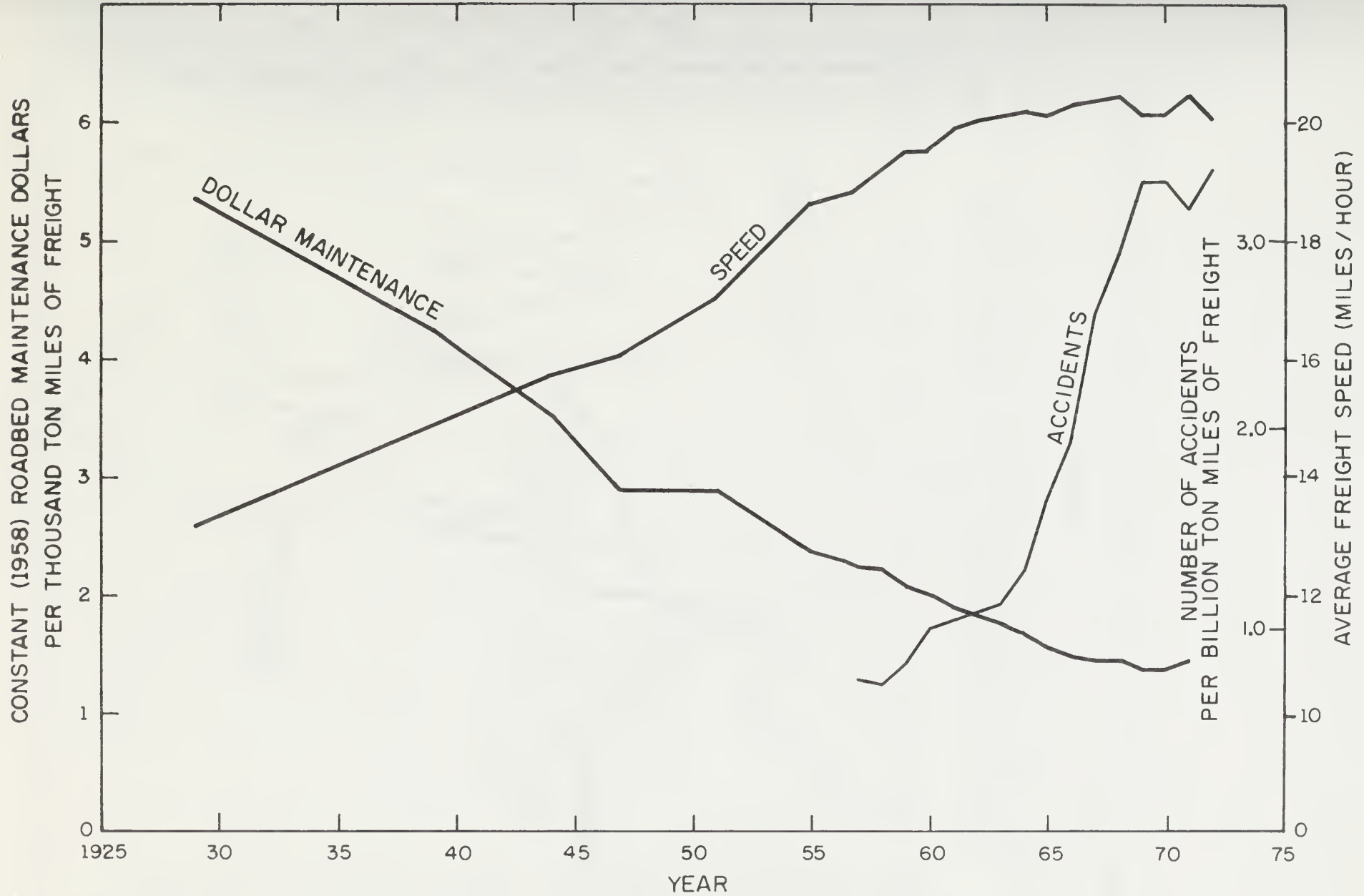

FIGURE 3. CONSTANT DOLLAR ROADBED MAINTENANCE PER 1000 TON MILES, RAIL FREIGHT SPEED, AND RIGHT-OF-WAY MAINTENANCE-RELATED ACCIDENTS PER BILLION TON MILES PER YEAR, 1929-1972, FOR RAILROADS. (Ton miles; Association of American Railroads (1973a, p. 16), Dollars; Department of Commerce (1966), Speed; Association of American Railroads, 1973a, p. 43-44, Accidents; Rodgers (1974)).

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15. Supplementary Notes

16. Abstracts

The operation of vehicular freight carriers (barge, train, truck) are examined for flexibility, costs, subsidies, regulation and resource demands. The conclusion reached is that trains compete with both barge and truck but the latter two do not compete with each other. Truck-train competition is reaching equilibrium while barge-train competition continues. Trains are substantially outsubsidized relative to the other two modes. Rail compaines have an unattractive financial status. Yet rail energy demands are the smallest for any mode on a freight ton-mile basis. Employment requirements of the three modes vary generally with the freight costs. Trucks re most sensitive to the dollar cost of fuel, water transport is slightly less sensitive than train transport.

The conclusion is that rail freight hauling should be protected from unequal government subsidies to other modes. Government withdrawal from the subsidy of freight transport is urged. In lieu of withdrawal, federal ownership and maintenance of the nations railways is recommended.

17. Key Words and Document Analysis. 17a. Descriptors

freight
railways
transportation
barge
trucks

17b. Identifiers/Open-Ended Terms

17c. COSATI Field/Group

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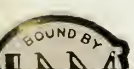
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